IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Larry C. Olsen et al.
Application No. 10/726,744
Filed: December 2, 2003
Confirmation No. 6833
For: THERMOELECTRIC DEVICES AND APPLICATIONS FOR THE SAME
Examiner: Anthony D. Fick
Art Unit: 1753
Attorney Reference No. 23-65037-01

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Date Mailed November 27, 2007

AMENDMENT

This responds to the Office action dated June 27, 2007. Please amend the referenced application as follows:

Amendments to the Claims are reflected in the listing of claims, which begins on page 2.

Remarks begin on page 6.

Claims

1. (Currently Amended) A thermoelectric power source comprising:

a flexible substrate having an upper surface; and

a thermoelectric couple comprising:

(a) a sputter deposited thin film p-type thermoelement positioned on the upper surface of the flexible substrate;

(b) a sputter deposited thin film n-type thermoelement positioned on the upper surface of the flexible substrate adjacent the p-type thermoelement; and

(c) an electrically conductive member positioned on the flexible substrate, and electrically connecting the first end of the p-type thermoelement with the second end of the n-type thermoelement, wherein the p-type or the n-type thermoelements comprise Bi_xTe_y, Sb_xTe_y, or Bi_xSe_y wherein x is about 2 and y is about 3.

2. (Original) The thermoelectric power source of claim 1 wherein the p-type or the n-type thermoelements have L/A ratios greater than about 20 cm^{-1}.

3. (Original) The thermoelectric power source of claim 1 wherein the p-type or the n-type thermoelements have L/A ratios greater than about 100 cm^{-1}.

4. (Canceled)

5. (Currently Amended) The thermoelectric power source of claim 1 wherein the p-type or the n-type thermoelements comprise Bi_xTe_y ~~are selected from the group Bi_xTe_y, Sb_xTe_y, and Bi_xSe_y alloys~~ where x is about 2 and y is about 3.

6. (Currently Amended) The thermoelectric power source of claim 1 further comprising at least about 50 thermoelectric couples, wherein the thermoelectric power source has a power output of at least about 1 μW with a voltage of ~~at least~~ at least about 0.25 volt.

7. (Original) The thermoelectric power source of claim 6 wherein the p-type or the n-type thermoelements are at least about 1 mm in length and at least about 0.1 mm in width.

8. (Original) The thermoelectric power source of claim 6 wherein the p-type or the n-type thermoelements are at least about 20 angstroms in thickness.

9. (Original) The thermoelectric power source of claim 1 further comprising at least about 1000 thermoelectric couples, wherein the thermoelectric power source has a power output of about 1W with a voltage of at least about 1 volt.

10. (Currently Amended) The thermoelectric power source of claim 1 wherein the p-type thermoelements each have a first width, the n-type thermoelements each have a second width, and the first width is different from the second width. ~~have different widths as compared to the n-type thermoelements.~~

11. (Original) The thermoelectric power source of claim 1 wherein two or more p-type thermoelements are positioned and electrically connected in parallel with one another and the parallel positioned p-type thermoelements are electrically connected in series to n-type thermoelements.

12. (Currently Amended) The thermoelectric power source of claim 1 ~~further including multiple thermoelectric couples electrically connected in series on the upper surface of the flexible substrate and~~ wherein the flexible substrate is in a coil configuration.

13. (Original) The thermoelectric power source of claim 1 wherein the volume of the thermoelectric power source is less than about 10 cm^3 and has a power output of from about 1 μW to about 1 W.

14. (Original) The thermoelectric power source of claim 1 wherein the volume of the thermoelectric power source is less than about 10 cm^3 and provides voltages of greater than about 1 volt.

15. (Original) The thermoelectric power source of claim 14 wherein the thermoelectric power source produces power at temperature differences of about 20°C or less.

16. (Original) The thermoelectric power source of claim 1 wherein two or more n-type thermoelements are positioned and electrically connected in parallel with one another and the parallel positioned n-type thermoelements are electrically connected in series to p-type thermoelements.

17. (Original) The thermoelectric power source of claim 1 wherein the n-type thermoelements are substantially free of selenium.

18. (Original) The thermoelectric power source of claim 1 wherein the flexible substrate is a polyimide.

19 – 22. (Canceled)

23. (Currently Amended) A thermoelectric power source comprising:

a flexible substrate having an upper surface;

multiple thermocouples electrically connected to one another on the upper surface of the flexible substrate, the thermocouples comprising:

sputter deposited thin film p-type thermoelements;

sputter deposited thin film n-type thermoelements alternatingly positioned adjacent the p-type thermoelements; ~~and~~

wherein the thermoelectric power source has a volume of less than about 10 cm^3 and has a power output of from about 1 μW to about 1 W; and

wherein the p-type thermoelements or the n-type thermoelements comprise a Bi_xTe_y, Sb_xTe_y, or Bi_xSe_y alloy where x is about 2 and y is about 3.

24. (Currently Amended) The thermoelectric device of claim 23 wherein said multiple thermocouples electrically connected to one another are ~~in series or~~ in series-parallel.

25. (Currently Amended) The thermoelectric power source of claim 23 wherein the p-type thermoelements have L/A ratios greater than about 20 cm^{-1} ~~have different widths as compared to the n-type thermoelements~~.

26 – 36. (Canceled)

37. (New) A thermoelectric power source comprising:

a flexible substrate having an upper surface; and

a thermoelectric couple comprising:

(a) a sputter deposited thin film p-type thermoelement positioned on the upper surface of the flexible substrate;

(b) a sputter deposited thin film n-type thermoelement positioned on the upper surface of the flexible substrate adjacent the p-type thermoelement; and

(c) an electrically conductive member positioned on the flexible substrate, and electrically connecting the first end of the p-type thermoelement with the second end of the n-type thermoelement, wherein the p-type or the n-type thermoelements comprise Bi_xTe_y where x is about 2 and y is about 3; and

(d) wherein the flexible substrate is in a coil configuration.

38. (New) The thermoelectric power source of claim 37 wherein the p-type thermoelements or the n-type thermoelements are at least about 1 mm in length and at least about 0.1 mm in width.

39. (New) The thermoelectric power source of claim 37 wherein the volume of the thermoelectric power source is less than about 10 cm^3 and has a power output of from about 1μW to about 1W.

Remarks

By this Amendment, claims 1-3, 5-18, 23-25, and 37-39 are pending. Reconsideration is respectfully requested.

Rejections under 35 U.S.C. § 102(b)

Claims 1, 4-6, 13-15, 17, 18, and 23 are Rejected Under § 102(b) Over DE '309

Claims 1, 4-6, 13-15, 17-18 and 23 are rejected under 35 U.S.C. § 102(b) as allegedly being anticipated by German Patent No. DE 297 23 309 UA ("DE '309"). Applicants traverse.

Claim 4 is cancelled by this Amendment, so this rejection is now moot as to claim 4.

Claim 1

Amended claim 1 recites a thermoelectric power source comprising, in part, p-type or n-type thermoelements comprising Bi_xTe_y, Sb_xTe_y, or Bi_xSe_y where x is about 2 and y is about 3. DE '309 does not teach or suggest the particular alloys claimed, and even if it did, it is not enabled for the claimed alloys.

DE '309 discloses only the genus bismuth telluride as material for the thermoelements but does not teach or suggest any of the claimed thermoelement alloys.

First, there is no disclosure in DE '309 at all in regard to a genus or species of antimony telluride or bismuth selenide. Further, DE '309 only once mentions the bismuth telluride genus: ". . . thermoelectric highly effective materials of the bismuth telluride type. . . ." (DE '309 English translation, Page 2, Para. 4.)

A genus will only anticipate a species if "one of ordinary skill in the art is able to 'at once envisage' the specific compound within the generic chemical formula . . . . One of ordinary skill in the art must be able to draw the structural formula or write the name of **each of the compounds included in the generic formula** before any of the compounds can be 'at once envisaged.'" MPEP § 2131.02, citing *In re Petering*, 301 F.2d 676, 133 USPQ 275 (CCPA 1962) (emphasis added) and MPEP § 2121.01. Because there is a virtually unlimited number of Bi_xTe_y alloys that belong to the bismuth telluride genus, one of ordinary skill in the art would not be able to "at once envisage" each of the compounds included in the generic formula, including the specific alloys recited in claim 1. Therefore claim 1 is not anticipated by DE '309. Additionally,

"[t]he fact that a claimed species or subgenus is encompassed by a prior art genus is not sufficient by itself to establish a *prima facie* case of obviousness." MPEP § 2144.08, citing *In re Baird*, 16 F.3d 380, 392, 29 USPQ 2d 1550, 1552 (Fed. Cir. 1994).

DE '309 does not enable the BiTe genus or any Bi_xTe_y alloy species.

Even if one were to assert that disclosure of the bismuth telluride genus was sufficient to teach or suggest the specific claimed bismuth telluride species (which it is not), DE '309 still fails to enable one of ordinary skill in the art as to how to make the alloy species. Prior art references must be enabling for an Examiner to rely on the reference as a prior art rejection. MPEP §§ 2131.01(A) and 2121.01.

The disclosure in an assertedly anticipating reference must provide an enabling disclosure of the desired subject matter; mere naming or description of the subject matter is insufficient if it cannot be produced without undue experimentation. Elan Pharm., Inc. v. Mayo Found. For Med. Educ. & Research, 346 F.3d 1051, 1054, 68 USPQ 2d 1373, 1376 (Fed. Cir. 2003). Determining how to make the claimed alloys and which were best-suited to the claimed power source took extensive study and testing. With the Applicants' disclosed co-sputtering methods of making the specific claimed alloys, there is virtually an infinite number of possible species of alloys that could be made. As is illustrated by review of FIG. 11, extensive experimentation was required to produce the claimed alloys. As can be seen, many parameters affect what species of alloy will be produced, including sputtering power, sputtering temperature, distance from the sputter target, etc. All of these parameters were varied in numerous experiments to produce different alloys. These different alloys were then tested to determine the combination that led to a desirable and efficient relationship between the seebeck coefficient and electrical conductivity for both the n-type thermoelement and the p-type thermoelement. Accordingly, it is clear that a person of ordinary skill in the art would not have understood from the single mention of the genus bismuth telluride in DE '309 what specific alloys would be useful or how to make such alloys without conducting extensive, time consuming, and costly experimentation.

Because the DE' 309 reference does not teach, suggest, or enable the alloys recited in amended claim 1, claim 1 is allowable over the art of record.

Claims 5, 6, 13-15, and 17-18

Dependent claims 5, 6, 13-15, and 17-18 are allowable over the DE '309 reference for at least the same reasons as set forth with respect to claim 1 and based on the dependent claims' unique and non-obvious combination of features.

For example, at no point does DE '309 teach or suggest a thermoelectric power source comprising at least about 50 thermoelectric couples and having a power output of at least about 1 μW with a voltage of at least about 0.25 V as recited in claim 6. Rather, DE '309 describes a thermoelectric power source with several films "coated with thermocouples" and containing "approximately 100 films." (DE '309 English translation, Page 2, Para. 2) DE '309 further states: "At a 10 K temperature difference, a voltage of approximately 3 V and a power of roughly 10 μW can be achieved. . ." (DE '309 English translation, Page 2, Para. 4.) Thus, the described configuration of approximately 100 films that have a power output of roughly 10 μW and 3 V does not teach or suggest the thermoelectric power source as recited in claim 6.

Additionally, at no point does DE '309 teach or suggest n-type thermoelements which are substantially free of selenium as recited in claim 17. As discussed above, DE '309 merely describes the genus bismuth telluride but does not teach, suggest, or enable any of the claimed species of bismuth telluride alloys. Because DE '309 is completely silent as to the presence or absence of selenium, DE '309 does not teach, suggest, or enable, and accordingly claim 17 is allowable.

DE '309 also does not teach or suggest the thermoelectric power source wherein the flexible substrate is a polyimide, as recited in claim 18. DE '309 only once refers to a flexible substrate and states that:

> In WO 89/00152, the thermocouples are deposited in a sinuous pattern on a film strip. The film strip is rolled up. **Rolling up with any given small bending radius is not possible**, however, since the strip cannot be sharply bent to any extent, because this will subject the thermoelectric layers to high mechanical loading, which produces a drastic increase in its electrical resistance and/or said layers are destroyed by micro cracks.

DE '309 English translation, Page 1, Para. 4.

DE '309 does not teach or suggest a flexible substrate, much less a flexible substrate that is a polyimide as recited in dependent claim 18. In fact, DE '309 specifically **teaches away** from rolling a flexible substrate by stating that it would subject the thermoelectric layers to high

mechanical loading which produces a drastic increase in its electrical resistance and/or the layers are destroyed by micro cracks. Instead DE '309 discloses the use of, "[s]everal films . . . coated with thermocouples, contacts and metallized surface [that] are **tightly stacked on top of each other** and electrically connected with each other." DE '309 English translation, Page 2, Para. 2. Because DE '309 teaches away from the flexible substrate comprising a polyimide as recited in claim 18 DE '309 does not teach or suggest the power source of claim 18.

Claim 23

Independent claim 23 recites, in part, p-type thermoelements or n-type thermoelements comprising a Bi_xTe_y, Sb_xTe_y, or Bi_xSe_y alloy where x is about 2 and y is about 3. As described above with reference to amended claim 1, DE '309 does not teach, suggest, or enable the recited Bi_xTe_y, Sb_xTe_y, or Bi_xSe_y where x is about 2 and y is about 3 as recited in independent claim 23. DE '309 therefore does not anticipate the thermoelectric power source recited in claim 23.

Rejections under 35 U.S.C. § 102(e)

Claims 1-5, 10, and 18 are Rejected under 35 U.S.C. § 102(e) - Stark

Claims 1-5, 10, and 18 are rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by U.S. Patent Publication No. 2004/0231714 to Stark et al. ("Stark"). Applicants traverse.

Although Applicants do not believe the Stark publication anticipates or makes obvious the subject claims, submitted herewith is a Declaration Under 37 C.F.R. § 1.131 documenting that the inventors conceived and reduced their invention to practice in the United States prior to the effective date (May 19, 2003) of the Stark publication. Thus, the Stark publication is not available as prior art, and the rejection is now moot.

Rejections under 35 U.S.C. § 103(a)

Claims 23-25 are Rejected Under 35 U.S.C. § 103(a) - Stark

Claims 23-25 are rejected under 35 U.S.C. § 103(a) as allegedly being obvious over Stark. Applicants traverse.

As discussed above, though Applicants do not believe the Stark publication anticipates or makes obvious the subject claims, the Stark publication is no longer available as prior art, and thus these rejections are now moot.

Claims 6-9, 11, and 13-16 are Rejected Under 35 U.S.C. § 103(a) - Stark

Claims 6-9, 11, and 13-16 are rejected under 35 U.S.C. § 103(a) as allegedly being obvious over Stark. Applicants traverse.

As discussed above, though Applicants do not believe the Stark publication anticipates or makes obvious the subject claims, the Stark publication is no longer available as prior art, and thus these rejections are now moot.

Claims 12 and 17 are Rejected Under 35 U.S.C. § 103(a) – Stark in View of Barr

Claims 12 and 17 are rejected under 35 U.S.C. § 103(a) as allegedly being obvious over Stark and further in view of U.S. Patent No. 4,036,665 to Barr et al. ("Barr"). Applicants traverse.

As discussed above, though Applicants do not believe the Stark publication anticipates or makes obvious the subject claims, the Stark publication is not available as prior art, and thus these rejections are moot with respect to the Stark publication.

Claim 12

Claim 12 recites a thermoelectric power source comprising, in part, p-type or n-type thermoelements comprising Bi_xTe_y, Sb_xTe_y, or Bi_xSe_y where x is about 2 and y is about 3. Barr does not teach, suggest, or enable, nor does the Examiner contend that Barr teaches, suggests, or enables the particular bismuth telluride alloys forming p-type or n-type thermoelements as recited in claim 12.

With regard to the use of antimony telluride or bismuth selenide, at no point does Barr even mention the use of such compounds as thermoelements as recited in claim 12.

With regard to the use of bismuth telluride, like DE '309, Barr only mentions the genus bismuth telluride. Specifically, Barr states: "[The semiconductor] thermoelectric elements 14 preferably comprise P- and N-type bismuth telluride strips 16 and 18, respectively." Barr, 2:43-45. At no point, however, does Barr teach or suggest any particular species of a bismuth telluride alloy, nor how to make any particular species. Thus, Barr does not teach or suggest the currently claimed bismuth telluride alloy species.

Even if one were to assert that disclosure of the bismuth telluride genus was sufficient to teach or suggest the specific claimed bismuth telluride species, Barr fails to enable one of

ordinary skill in the art as to how to make any of the claimed alloy species (or any species at all). As discussed above, a prior art reference must be enabling for an Examiner to rely on the reference as a prior art rejection. (MPEP § 2131.01(a).) Because extensive experimentation was required both to choose as suitable and how to make the claimed bismuth telluride alloys, Barr does not enable the claimed alloys and thus does not render claim 12 unpatentable.

Claim 17

Claim 17 recites a thermoelectric power source comprising, in part, p-type or n-type thermoelements comprising Bi_xTe_y, Sb_xTe_y, or Bi_xSe_y where x is about 2 and y is about 3. As described above with reference to dependent claim 12, Barr does not teach, suggest, or enable the recited thermoelements as recited in claim 17 and thus claim 17 is allowable.

Claims 19-22 are Rejected Under 35 U.S.C. § 103(a) – Stark in View of Venkatasubramanian

Claims 19-22 are rejected under 35 U.S.C. § 103(a) as allegedly being obvious over Stark and further in view of U.S. Patent Publication No. 2003/0099279 to Venkatasubramanian et al. ("Venkatasubramanian"). Applicants traverse.

Claims 19-22 are herein cancelled so these rejections are now moot.

Should the Examiner have any questions or need for further information, the Examiner is requested to contact the undersigned at the below noted telephone number

Respectfully submitted,

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